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24 SUSSEX DRIVE

ENGINEERING REPORT

SEPTEMBER 1984

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1. INTRODUCTION

The purpose of this Study, commissioned by Public Works Canada and conducted during August 1984, is to analyze the condition of the residence at 24 Sussex Drive and to recommend remedial work and new services required to enable the building to function in its offical capacity.

The original house was built in 1868 and was expropriated by the Crown in 1946. In 1950 the building was gutted and completely rebuilt for the purpose of providing an official residence for the Prime Minister. The house, as it appears to-day, bears little resemblance to the Victorian original, but has been designated as a Heritage building.

Reconstruction of the house, while complying with the standard practices of 1950, did not produce an efficient and well insulated building which would ensure comfortable living conditions for the occupants.

A requirement of this residence is that it be suitable not only as a home for the Prime Minister and his family, but also for formal entertaining on a large scale.

The areas examined in this Study are as follows:

Building Envelope and Structural Elements
Plumbing
Heating
Ventilation and Humidification
Air Conditioning
Sprinkler System
Electrical Distribution
Fire Detection and Alarm
Ground Fault Protection
Telephone and CATV Systems
Emergency Power
Lightning Protection
Swimming Pool

1. INTRODUCTION - cont'd

The original Architectural, Mechanical and Electrical floor plans used in the preparation of this Study were not amended at the completion of construction to show "as-built" conditions. Subsequent changes were also not recorded but are shown on the miniature floor plans on pages 1 through 4 of this report.

Assistance by Public Works Canada staff and Mrs. B. Cleary in the preparation of this report is acknowledged with thanks.

2. CONCLUSIONS AND RECOMMENDATIONS

This residence is now considered a National Monument and, as such, should reflect the position of the highest elected official in the land.

Since 1950 the only major alterations to the residence have been the enclosure of the back patio, the modernization of the kitchen and pantry, the first floor family room, and the addition of the pool building with connecting tunnel. Very little upgrading of the building envelope or mechanical services has been implemented over the past 34 years. There is evidence that some of the repairs and alterations made have not solved the cause of the original problems. Continuous official use of the residence has obviously limited the time allowed to perform and supervise any construction work, consequently there are examples of poor workmanship.

Contained in this report are steps necessary to:

(a) Make repairs to or replace systems which are hazardous or which could fail in the near future.

(B) Correct problems experienced by the occupants.

(c) Install new services, such as air conditioning, for the comfort of the occupants.

It is recommended that all of the deficiencies reported in this Study be corrected, subject to available funding and the ability to gain access to the building for construction. A budget of approximately $600,000 is required to implement all of the recommendations.

The work recommended has been divided into 'packages', each with its estimated budget cost and projected time to implement its installation. (Construction schedules for the various packages are shown in the appendices). Budget costs and construction time are based upon the free use of the construction area during regular working hours. Additional costs can be anticipated if work is interrupted.

2. CONCLUSIONS AND RECOMMENDATIONS - cont'd

Estimated cutting and patching have been included but it is recommended that skilled day labour be provided to ensure that this work is done carefully and that surface refinishing is kept to a high standard.

Apart from maintenance and superficial items, it is unrealistic to consider proceeding with any of the major items while the residence is occupied. To proceed with the work in a 'piece-meal' manner will incur additional costs and produce results which are less satisfactory.

Ideally, any new construction work should take place during the summer if the house could be vacated, after preparing contract documentation during the previous winter.

The following summary of packages is suggested:

Package "A" - Priority Items:	Estimated Budget Cost
Build new dwarf walls to support roof rafters:	$ 8,000
Rebuild or repoint top sections of chimneys:	$ 20,000
Replace all existing wiring devices:	$ 4,500
Replace fire detection/alarm system:	$ 15,000
Install ground fault devices:	$ 1,200
Install lightning protection:	$ 7,500
Repair roof of living room bay window and build new deck off master bedroom:	$ 4,000
	$ 60,200

* Estimated Time to Complete: 28 weeks

Package "B" - Upgrading of Building Envelope:	Estimated Budget Cost
Replace all windows:	$ 90,000
Additional attic insulation:	$ 4,500
Insulate basement crawl spaces & storage areas:	$ 6,000
	$100,500

* Estimated Time to Complete: 37 weeks

* See appendices for project schedules

2. CONCLUSIONS AND RECOMMENDATIONS - cont'd

Package "C": Upgrading of Mechanical and Electrical Systems	Estimated Budget Cost
Replace all bathroom fixtures and galvanized piping:	$ 35,000
Clean all convectors and modify to increase efficiency:	$ 5,300
Increase heating capacity in kitchen, pantry, family room, staff dining, storage room and main entrance:	$ 8,700
New bathroom exhaust & replacement air system:	$ 9,500
New kitchen exhaust and replacement air system:	$ 17,600
New oven vents to outside:	$ 1,200
New laundry room exhaust:	$ 2,200
Modify sewing room exhaust system:	$ 600
Relocate freezer condensing unit:	$ 500
Replace electrical branch circuits:	$ 42,000
Replace electrical panels:	$ 1,500
New telephone and CATV distribution system:	$ 4,500
	$128,600

Estimated Time to Complete: 36 weeks

Package "D" - New Systems	Estimated Budget Cost
Complete air conditioning system:	$ 90,000
New sprinkler system:	$ 95,000
New battery emergency power:	$ 14,000
	$199,000

Estimated Time to Complete: 40 weeks

Package "E" - Pool Building	Estimated Budget Cost
Replace pool ventilation unit with dehumidifier system:	$ 24,000
Install skylight supply air system:	$ 2,800
Replace pool skylights:	$ 12,000
Replace sun lounge sliding doors:	$ 3,200
Install new glazed partition between pool area and sun lounge:	$ 7,000
	$ 49,000

Estimated Time to Complete: 36 weeks

Note: A separate break-down of all recommendations, with individual cost estimates and on-site construction time is listed in the appendices.

Any new work proposed should be co-ordinated with Architectural and Interior Design personnel assigned to the building. Changes in interior decoration normally made at each change in occupancy should be checked to ensure that building services (such as heating) will continue to function correctly. All new work should be recorded and "as-built" data recorded on a master set of plans.

3. BUILDING ENVELOPE AND STRUCTURAL ELEMENTS:

1. Roof and Roof Framing:

The roof of the building consists generally of steeply pitched rafter framing around the perimeter and a central portion with a flat roof. The flat roof consists of wood rafters, tongue and groove wood decking and a conventional four-ply tar and gravel built-up roof membrane. The flat roof occurs at two elevations; the roof elevation of the westerly two-thirds of the building is about six feet higher than the easterly portion.

The steep roofs are shingled with manufactured western cedar shingles. Apart from some touching up of the flashings the main roofs appear to be in good condition.

The stone chimneys above the roof have deteriorated, evidenced by loose mortar joints and cracked stones. Falling masonery is a potential hazard and immediate attention is required.

The copper roof above the Family Room bay window was damaged by the ice removal crew; the torn seam observed has now been repaired and further damage to the ceiling below should not occur. The eavestroughing at the edge of this roof has a heating cable for ice melting.

On the small balcony outside the Master Bedroom wood duckboards have been placed directly on the roof over the Living Room bay window. It is probable that the water damage to the ceiling below was caused by the duckboard supports penetrating the roofing, however this diagnosis is complicated by the observation of dry rot at the base of the door frame which should be looked at when repairs are made.

3. BUILDING ENVELOPE AND STRUCTURAL ELEMENTS:

1. Roof and Roof Framing - cont'd

There is evidence that ice has built up in the roof valley on the northeast side as the copper has been damaged by the ice removal crew.

Two distinct attic spaces (the west attic and the east attic) are accessible. In each, the horizontal roof rafters, the ceilings joists and the top portion of the steeply pitched perimeter rafters are visible.

An inspection of the attic space revealed some irregularities in the wood framing. A description of the existing framing and the recommended method of reinforcement follows:

1. West Attic:

The framing in this five foot high attic space reflects the past renovations to the original building. Portions of the original roof (circa 1865) and two stone chimneys interrupt the regular framing.

At the western end of this attic, nominal 2"x 8" rafters at 24" on centre span approximately thirteen feet north and south. At the north and south sides of the roof the rafters are supported on a double 2" x 8" beam. At their interior end the rafters frame into either a diagonal hip rafter supported on a nominal 3"x 4" post or on short lengths of 2"x 4" at 24" nominal on centre supported by dwarf walls. An additional 2"x 4" dwarf wall is located five feet north of the south side of the flat roof. All of the dwarf walls and the 3"x 4" post are supported on 2"x 8" ceiling joists at 13" on centre.

3. BUILDING ENVELOPE AND STRUCTURAL ELEMENTS - cont'd

1. Roof and Roof Framing - cont'd

1. West Attic - cont'd

The irregular location of dwarf walls, poor construction practice and inadequate support of the roof rafters indicate that the roof framing has been altered by individuals inexperienced in structural renovations.

Analysis, using basic engineering principles, indicates that the existing roof rafter support is inadequate for the snow load of 48 lbs. per square foot required in Ottawa by the latest National Building Code of Canada. In our opinion the roof has not previously shown signs of distress only because of its windswept location, the relatively light attic insulation, and the robust construction of the older timber framing.

2. East Attic:

The framing in this four foot high attic space is generally of older, heavy timber construction. Rafters 3"x 9" in size at 17" on centre span 15'-6" north and south between two 4"x 12" beams. These beams were designed for two spans of approximately 12 ft. each between three heavy 5"x 9" rafter frames. Subsequent to construction the two supporting inclined rafters in the central frame were cut completely off. The cut 5"x 9" rafter was replaced by a nominal 2"x 4" post on the north side and by a poorly constructed dwarf wall on the south side. Again, the windswept location, light attic insulation, and robust original construction have, so far, prevented serious damage.

3. BUILDING ENVELOPE AND STRUCTURAL ELEMENTS - cont'd

1. Roof and Roof Framing - cont'd

3. Recommendations:

The condition of the chimneys and the inadequate support of the roof rafters constitute safety hazards and require immediate rectification.

Construct a total of five new lines of dwarf walls in the west end of the attic space between the rafters and the ceiling joists. The new dwarf walls would run in an east-west direction.

Construct two new lines of dwarf walls in the east attic between the 2"x 10" ceiling joists and the 4"x 12" beams.

Drilling and screwing would reduce the chance of damaging existing finishes and would keep noise to an acceptable level.

The corrective measures are intended to distribute the roof loads into the existing structural framing in a uniform manner.

This remedial structural work and the rebuilding or repointing of the chimneys should be undertaken immediately.

Estimated Budget Costs:

Structural Modifications to Attic:	$ 8,000
Chimney Rebuilding and Repointing:	$20,000

3. BUILDING ENVELOPE AND STRUCTURAL ELEMENTS - cont'd

2. Windows:

The occupants have complained that the house is drafty. The major sources of infiltration of cold are the windows and doorways -- but primarily the windows.

With few exceptions the windows are double-hung vertical sliding wood windows with an interior sul sash. These windows were considered modern when installed in 1950, but they have since been found ineffective. Rusco steel storm sash and screens were installed later in an attempt to rectify the drafty situation. In many cases, where windows are not frequently opened or cleaned, the Rusco windows are still tight but in the critical areas these steel units have become worn out and are no longer tight fitting.

The old windows have been the source of infiltration for years and attempts at tightening, weatherstripping etc. have obviously been made. In our opinion these windows are no longer capable of further adjustment or rectification in a practical manner.

The Family Room is an exception, where the old windows have been replaced with large, flat hermetically sealed glazing units, set in narrow, extruded aluminum frames without thermal breaks. These units were installed to improve comfort in winter but the radius of curvature of the wall is too small for the windows and exposed stone-work can be felt when the damaged wall cloth is pulled back. The damage observed is caused by moist air from an efficient humidifier in the room condensing on the cold stone wall.

3. BUILDING ENVELOPE AND STRUCTURAL ELEMENTS - cont'd

2. Windows - cont'd

Recommendations:

To correct the draft problems reported by the occupants, all of the windows should be replaced. Windows of better and more efficient design are now readily available and it is recommended that such units be installed.

The appearance of the new windows selected must be as close as possible to the original without sacrificing efficiency. Simple grid subdividers set onto hermetically sealed units will produce the desired appearance as well as a suitable insulating factor. Curved, hermetically sealed units are readily available by custom order and spare glazing units could be ordered for the selected curves and sizes to simplify future replacement.

The existing wood frames which are in good condition should be retained. Existing window sashes should be removed and the frames cleaned and painted. New hardware and sash would be installed along with minor matching trim. To facilitate easy cleaning, a rotating type release on the sliding sash is recommended.

This simple replacement will reduce considerably the site work and eliminate almost entirely the cutting and patching normally associated with replacing wood windows.

The new windows tentatively selected would be vinyl clad wood presenting white to the exterior, and a paintable surface to the interior. The aluminum framed windows in the Family Room would be replaced with triple glazed, full curved units in thermally broken frames.

3. BUILDING ENVELOPE AND STRUCTURAL ELEMENTS - cont'd

2. Windows - cont'd

Recommendations - cont'd

An alternative program for the replacement of the windows could be planned whereby all windows would be ordered at once, and installed as opportunity or as redecorating would permit.

Estimated Budget Cost: $90,000

This cost covers the replacement of the windows as recommended and includes door sidelights and large uncluttered glazing. It does not include for the north-facing, enclosed back patio.

3. Walls and Ceilings, Insulation and Vapour Barrier:

The thick, self-supporting and load bearing walls are subject to damage if excessive moisture condenses and freezes in the mortar joints. This type of damage is evident in the top sections of the chimneys. In the walls, however, the mortar joints and stonework appear to be in reasonable condition, with only minor repointing required.

The mason responsible for repointing should record the mortar mix and tool and should reinspect the work every two years.

3. BUILDING ENVELOPE AND STRUCTURAL ELEMENTS - cont'd

3. Walls and Ceilings, Insulation and Vapour Barrier:

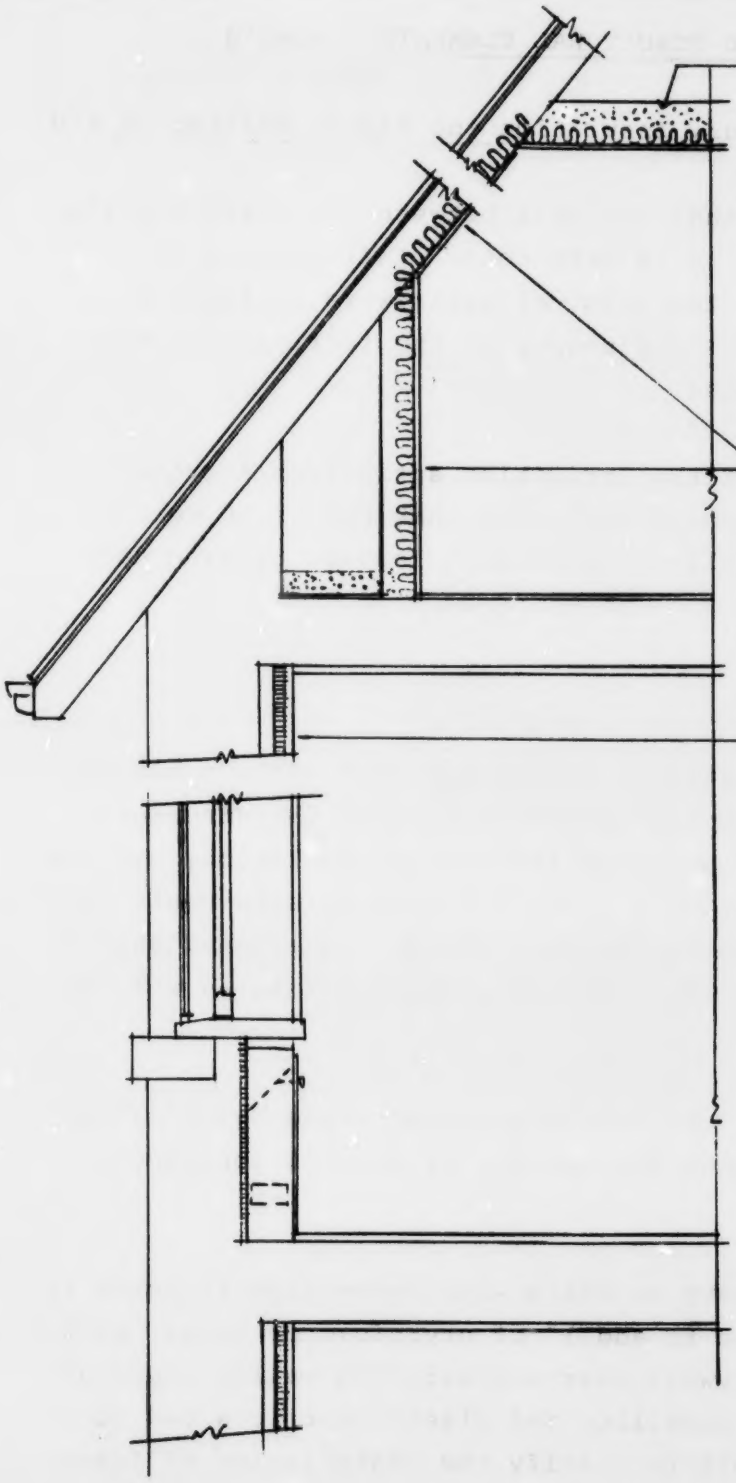
The ground and first floor walls are insulated with 1" thick tentest, with an air space on the inside at the stonework. Some rooms have vinyl wall cloth but elsewhere paint provides the only form of vapour barrier.

There is water damage on the east wall of the Family Room, likely caused by a leaking flashing or condensation forming where infiltration occurs.

On the second floor the stud-framed knee walls are filled with 3" thick rockwool batts and in most areas the walls and ceilings are finished with foil-backed gypsum boards. 3" thick rockwool batts are placed between the ceiling rafters and covered by approximately 3" of blown-in rockwool. It was not determined, after removal of an eaves board, whether there is any insulation in the roof over the Family Room bay window.

Several vents are provided in the attic space for air circulation. There are no vents in the eaves of the roof over the Family Room bay window and the stone wall extends up to the rafters.

In the basement only the wall of the crawl space below the dining room is insulated. Wood strapping has been attached to the stone wall and 2" thick fibreglass attached and covered by a 6 mil plastic vapour barrier and drywall. The bedrock floor of the crawl space is covered with plastic and a 1" thick layer of loose vermiculite. Ground water has seeped past the plastic and the insulation at the floor is wet, causing deterioration of the drywall. The installation is unsatisfactory.



ROOF

Outside Surface	0.61
3" Loose Rockwool	8.48
3" Rockwool Batts	7.95
Gypsum Board	0.32
Inside Surface	0.61
R=	17.97 BTU/H.ft^2°F

KNEEWALL & SLOPING ROOF

Outside Surface	0.17
Shingles	0.94
Wood Sheathing	0.98
Air Space	0.90
3" Rockwool Batts	7.95
Drywall	0.33
Inside Surface	0.68
R=	17.90 BTU/H.ft^2°F

WALL

Outside Surface	0.17
Stone	1.92
Air Space	0.97
1" Tentest	1.82
Lathe & Plaster	0.41
Inside Surface	0.68
R=	5.97 BTU/H.ft^2°F

FIGURE 5

SYSTEM SCHEMATIC WALL AND ROOF INSULATION

PROJECT 24 SUSSEX DRIVE

3. **BUILDING ENVELOPE AND STRUCTURAL ELEMENTS** - cont'd

3. Walls and Ceilings, Insulation and Vapour Barrier-cont'd

It was reported that the wall between the staff sitting room and the pantry is very cold. Infiltration is suspected, where two original walls were enclosed by a new wall in 1950. The source of the infiltration must be found and sealed.

It was noted that the irrigation sprinklers are too close to the basement walls and that the light well drains are partially plugged with leaves, causing damp basement walls.

Recommendations:

Additional insulation to bring the roof up to a minimum of R 30 can be applied after correcting the structural deficiencies. Blow loose fibreglass insulation into the second floor knee wall space and install eave vents to circulate air behind the insulation. Additional second floor insulation will improve summer comfort as well as saving energy.

Install vents in the Family Room bay window roof eaves. Add insulation when the ceiling is removed for renovations.

In rooms which have no walls with decorative finishes it would be possible to add 1" of styrofoam or equal, with a foil-backed drywall over the existing walls. Several rooms have wood panelling and plaster cornices and it would be difficult to justify the installation of insulation and vapour barrier unless a major renovation is contemplated.

3. **BUILDING ENVELOPE AND STRUCTURAL ELEMENTS** - cont'd

3. Walls and Ceilings, Insulation and Vapour Barrier-cont'd

Recommendations - cont'd

Insulation under the Dining Room should be replaced by insulation with a low water absorption such as foam-glass. If polystyrene is used it should be enclosed in fire rated drywall. The crawl spaces under the main entrance, the staff sitting room and the storage rooms should be insulated in a similar manner.

The addition of insulation to upgrade the building envelope would allow a reduction in size of the unsightly heating convectors and possibly the use of a more appropriate type.

While work is proceeding in the basement, a small section of ceiling in the Laundry Room should be filled in to complete the fire separtion between floors. In addition, a vent to the small storage room (lined with cedar) on the northeast corner should be blocked on the outside.

The outside sprinklers should be relocated further from the basement walls to reduce moisture in the surrounding soil. Planting should be kept trimmed away from the stone walls to reduce moisture retention and allow a clear view along each wall for security.

Estimated Budget Costs:

Additional Roof Insulation:	$5,500
Insulate Basement Crawl Spaces and Storage Spaces and Block Openings in Ceiling and Outside Wall:	$6,000

4. PLUMBING:

1. Description of System:

With the exception of new sinks in the kitchen and pantry the installation has not been altered since 1950.

The large waste pipes are cast iron; galvanized piping was installed for the smaller wastes and vents. Hot and cold water piping is copper. There is no evidence of the galvanized piping having been replaced after 34 years and corrosion, leading to failure of waste pipes and resultant water damage can be anticipated. The life expectancy of galvanized waste pipes is about 20 to 25 years.

Plumbing fixtures are of good quality but are now obsolete, making replacement parts difficult to obtain.

Domestic hot water is supplied from the original copper hot water tank. The electric heating elements have been removed and water is now heated by an auxiliary boiler and circulated by a pump. The oil-fired heater is now being replaced by a gas-fired unit of similar capacity. Staff report that the hot water supply is adequate.

2. Recommendations:

All galvanized piping should be replaced by copper to prevent eventual failure and potential damage to the residence and its contents. Because most of the piping is contained within floor and wall spaces, the work required is extensive. New bathroom fixtures of equal quality should replace the existing.

Estimated Budget Cost: $35,000

(This estimate should be increased if custom fixtures or whirlpool bath accessories are required).

5. HEATING:

1. Description of System:

Heat is supplied by hot water convectors fed from boilers located in the basement. The piping system has three zones:

- Second floor,
- Basement, ground and first floor west,
- Basement, ground and first floor east.

Reverse-return pipe loops in the basement ceiling supply vertical branches connected to invidual convectors. Risers serving the first and second floors are concealed in the outside walls. The circulating pumps run constantly to prevent freezing.

Three new gas-fired boilers are now being installed to replace the original oil-fired units and will be fired in sequence by an indoor/outdoor controller; the temperature of the water supplied to each zone will be controlled by a room thermostat. Previously, the entire system was controlled by one thermostat in the Main Foyer.

Many of the cabinet convectors are recessed in the walls. On outside walls a layer of tentest behind the convector reduces heat loss from the cabinet. Some convectors in the family room on the first floor and in the formal rooms on the ground floor are built into wooden enclosures. The air inlet at the base of these enclosures is too small and the front panels do not fit closely to the heating elements, thus allowing air bypass.

In addition, the heating element can only be cleaned with difficulty, by removing the top grilles.

5. **HEATING** - cont'd

1. Description of System - cont'd

Elsewhere the convectors are contained in steel enclosures which incorporate manual dampers for heat regulation, and their covers can be removed for cleaning the interior. These steel enclosures have a 'dated' appearance and contrast with their surroundings. Convectors on the northeast wall of the Staff dining room and the adjacent storage room have been capped off and drained due to freezing. Those in the kitchen and pantry have no air inlet at their base and cannot function correctly. Consequently the kitchen area is very cold unless the stoves are operating and warm air from the remainder of the house is drawn in to make up for kitchen exhaust.

The family room on the first floor is also cold in winter due to the insufficient capacity of the convectors. The thermostat controlling two-way valves on each convector, installed a few years ago, does nothing to alleviate the problem.

When the curtains in the formal rooms are closed, air circulation through the convectors is reduced as the valances at the top are closed and the curtains hang close to the floor.

The second floor overheats, but this problem should be resolved by the new zone thermostat now being installed.

When large groups of people are entertained on the ground floor, the zone water temperature (which also supplies the first floor) will be reduced to prevent overheating of the ground floor. Heat stored in the building mass should prevent sub-normal temperatures on the first floor, provided that these rooms are not subjected to major cold air infiltration.

5. **HEATING** - cont'd

1. Description of System - cont'd

The house is used for entertaining and when the front door is opened repeatedly in winter, the entrance hall, main foyer and staff sitting room become cold. The convectors cannot restore the temperature quickly.

2. Recommendations:

1. General

1. Remove all convector covers and steam clean the heating elements. (It is most important to clean the underside of the elements).

2. Install a top hat section behind the convector covers to reduce air bypass and increase efficiency.

3. Increase height of air inlet on wooden convector enclosures.

4. Replace badly fitting fireplace dampers.

5. Modify curtain valances and provide larger gap between floor and bottom of curtain to increase air circulation. Co-ordination required with Interior Designers.

Estimated Budget Cost: $5,300

2. Increase Heating Capacity:

1. Install vertical recessed fan coil units complete with thermostats in kitchen and pantry to replace existing convectors inaccessible in outside wall.

2. Replace recessed convectors in the family room with a surface-mounted, continuous convector in a custom-built cabinet (illustrated on Page 26).

3. Replace recessed type convectors with new surface convectors in the staff dining room and the adjacent storage room.

4. Install new cabinet fan heater in the entrance vestibule to provide faster heat recovery when front door opened repeatedly, and connect to main supply header.

Estimated Budget Cost: $8,700

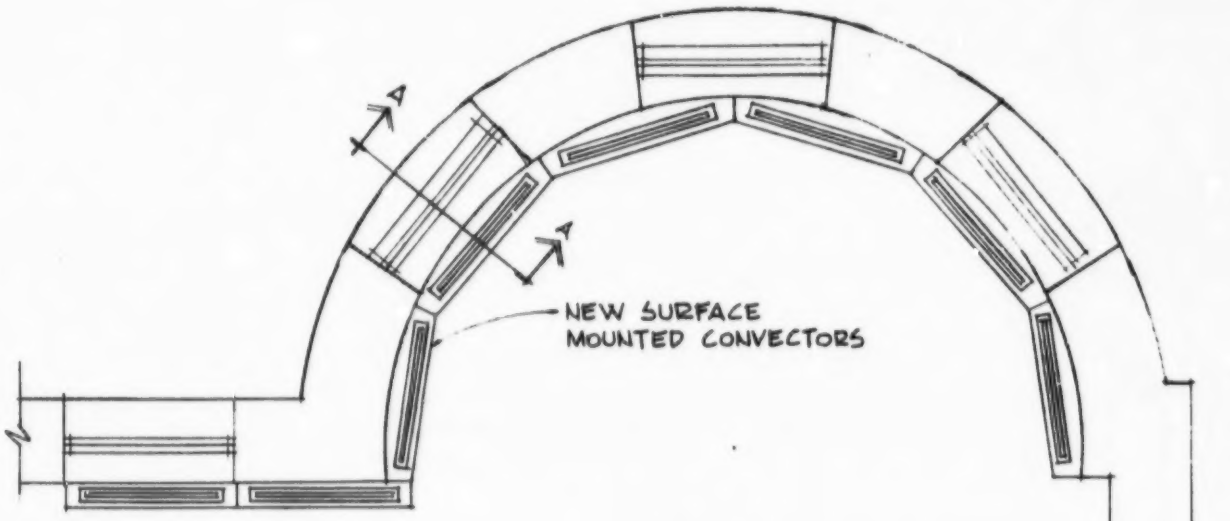
5. **HEATING** - cont'd

2. **Recommendations** - cont'd

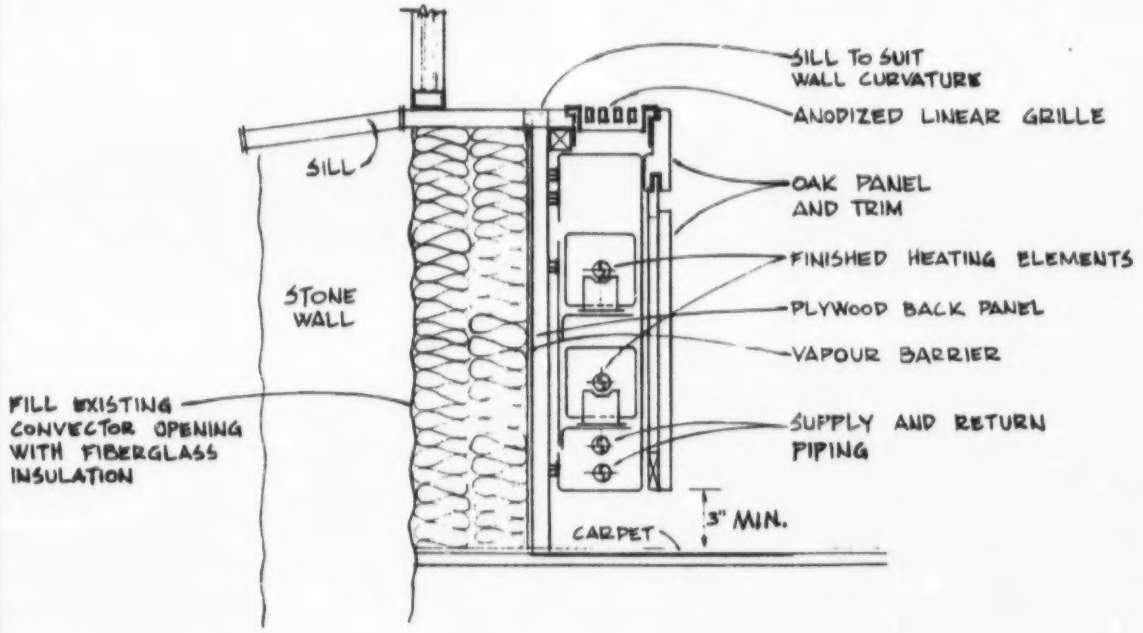
3. **Future Considerations:**

1. Replace recessed steel convectors with custom-built units similar to those recommended for the Family Room.

2. Additional insulation on the 2nd floor would allow the replacement of the large, clumsy cabinets with smaller baseboard units.



PART PLAN FAMILY ROOM



SECTION A-A

FIGURE 6

SYSTEM SCHEMATIC NEW HEATING CONVECTOR IN FAMILY ROOM

PROJECT 24 SUSSEX DRIVE

6. VENTILATION AND HUMIDIFICATION:

1. Description of System:

1. Bathroom Exhaust System:

The original system, ducted to an exhaust fan, is not in operation. Ceiling exhaust grilles on the ground floor remain but elsewhere they have been covered over. A second floor bathroom has a modern ceiling fan which discharges into the attic. All bathrooms have outside windows but are difficult to open in winter due to humidity buildup. This is injurious to the building over the long term.

The bathroom exhaust system will provide continuous ventilation in the house and remove moisture from the bathrooms. An air replacement system will supply fresh air to the house and reduce infiltration caused by negative pressure.

2. Kitchen Hood:

A stainless steel canopy with a CO_2 fire extinguisher system over the cooking area was installed in 1973. A small domestic-type aluminum grease filter is ducted to a fan mounted on the front wall of the residence. The horizontal duct can be cleaned only from the outside by first removing the fan. It is understood that this duct has not been cleaned since it was installed and this constitutes a potential fire hazard.

The wall ovens adjacent to the exhaust canopy have small vent pipes connected to the exhaust system but there is still a very high heat build-up in the cupboards above.

6. VENTILATION AND HUMIDIFICATION - cont'd

2. Recommendations:

1. Bathroom Exhaust and Replacement Air System:

Re-activate the existing system and install a heat recovery exhaust fan. This fan will exhaust air and supply preheated air into the building simultaneously. The heat exchange medium is easy to remove for cleaning or replacement. A small electric duct heater is required to bring the air to it final supply air temperature.

Estimated Budget Cost: $9,500

2. Kitchen Exhaust and Replacement Air System:

The existing canopy will be modified by the addition of commercial-type grease filters. The existing wall fan and duct system will be removed and replaced by a new 18 gauge, all-welded steel duct with cleanouts, installed in the existing unused incinerator shaft up to the sewing room.

Because of the lack of attic space at the east end, part of the sewing room will be required to house the exhaust fan and a replacement air fan with electric duct heater to heat the incoming air. The copper air intake and exhaust will be carefully integrated into the roof. The replacement air duct will be concealed in a closet on the first floor and will discharge through a grille in the kitchen ceiling.

Estimated Budget Cost: $17,600

Note: If this item is not implemented shortly, the existing exhaust duct should be thoroughly cleaned.

6. VENTILATION AND HUMIDIFICATION - cont'd

2. Recommendations - cont'd

3. Oven Vents:

Install brick vent in the wall where the kitchen exhaust is removed and duct the oven vents with a remotely controlled damper which will open when the ovens are in use. Insert rigid insulation between the oven and the cupboard on top.

Estimated Budget Cost: $1,200

4. Laundry Room Exhaust:

Replace the laundry exhaust with a new fan ducted to the back of the house and relocate the dryer vent outlet adjacent to the new outside louvre.

Estimated Budget Cost: $2,200

5. Sewing Room Exhaust:

Install an electric, motorized, low leakage type damper and wall grille.

Estimated Budget Cost: $600

(Note: If air conditioning is installed, this fan could be removed).

6. Humidification:

As described elsewhere, unless the building envelope is upgraded with the installation of a vapour barrier, additional humidification cannot be recommended. When the windows are replaced, the consequent reduction in air infiltration will lead to reduced loss of moisture and improved comfort.

7. AIR CONDITIONING

1. Description of Existing System:

Window air conditioners are installed in the kitchen, the pantry and the storage room adjacent to the Master Bedroom. These units are noisy and unsightly, and not appropriate for this residence.

The kitchen can become unbearably hot in summer when all of the equipment is in use. Part of the heat is contributed by an air-cooled condenser mounted on top of the reach-in freezer.

The formal rooms on the ground floor, used for entertaining, are not air conditioned. Windows are opened to provide air circulation but this is of little benefit during warm, humid weather when Ottawa can be very uncomfortable.

2. Concept for New System:

The important use of this residence and the the comfort of its occupents dictates that considerable care be taken in the selection of an appropriate air conditioning system. Design parameters are as follows:

1. Adequate cooling with individual control for all principal rooms and the kitchen area.
2. Unobstrusive appearance and quiet operation.
3. Little or no alteration to the living areas.
4. Ease of maintenance, with minimal requirements in main living areas.

These requirements can be met by the use of vertical fan coil units on the two principal floors, and horizontal fan coils with ductwork in the attic to serve the upper floor.

7. AIR CONDITIONING - cont'd

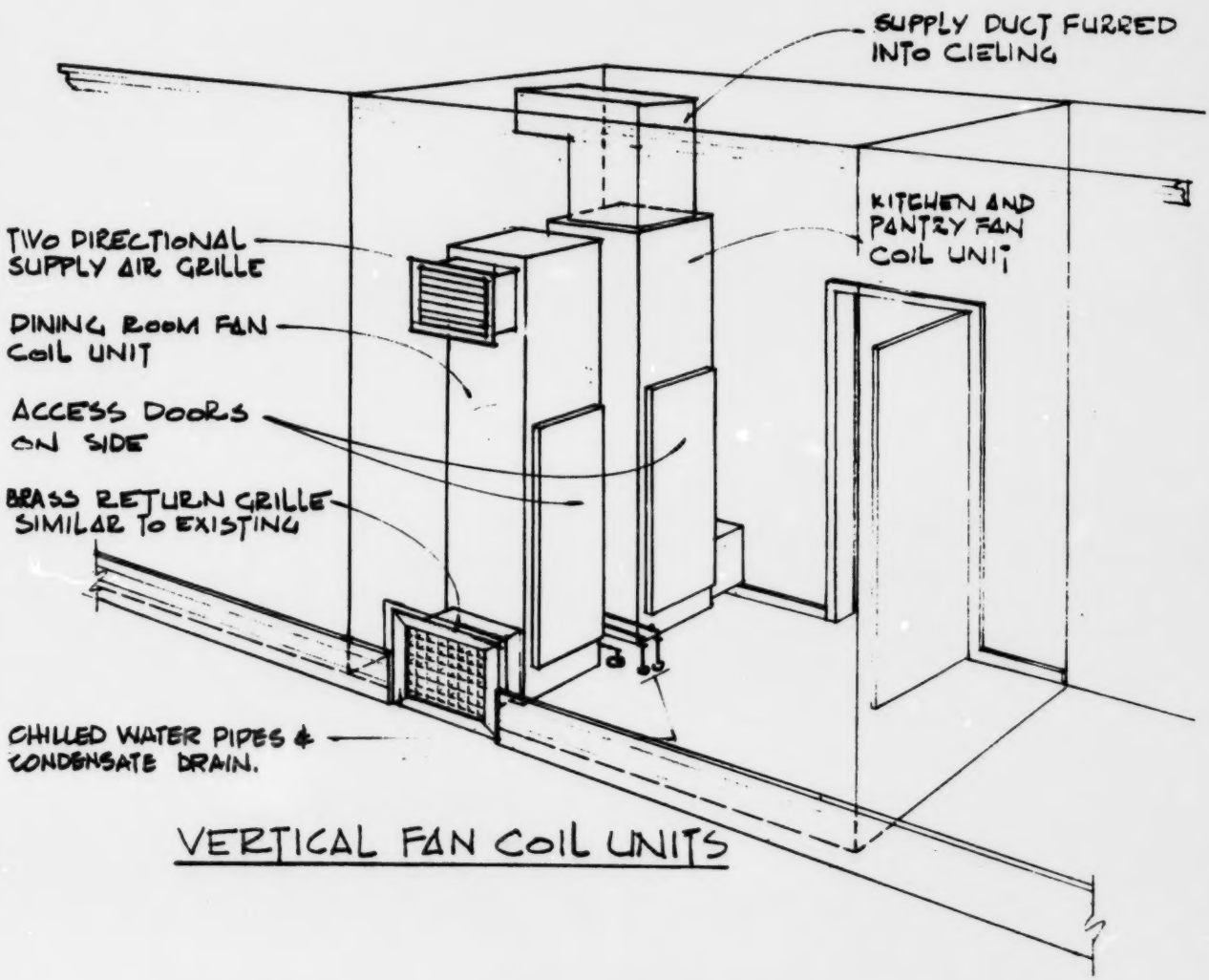
2. Concept for New System - cont'd

Suitable vertical fan coil units measure approximately 400mm x 400mm x 2000mm high and can be concealed in closets and storage rooms. Supply and return grilles can be installed in the walls of the rooms served. A typical arrangement is illustrated on page 33. Chilled water and condensate piping are concealed in closets and voids in the walls, and fed from the distribution system in the basement.

Each unit has its own 3-speed fan control and a thermostat to control the chilled water coil 3-way valve. The unit casing is acoustically lined.

A 10-ton capacity cold generator is envisioned, located to the west of the pool building (see Page 35). This remote location will isolate the compressor and condenser fan noise from the house and the garden terrace. The wood screen around the equipment would be designed to harmonize with the pool building and provide easy access for maintenance. The chilled water piping to the cold generator would be drained in winter to prevent freezing. However, if the cooling system is required to operate in winter, glycol would be used as the heat exchange medium.

As an alternative, the provision of a partial air conditioning system to serve only the principal rooms would be similar to the system described above but would entail the installation of a 5-ton capacity water-cooled cold generator in the basement of the pool building, with chilled water piped through the tunnel to the house. This system would eliminate the outside unit but could be used to partially heat the pool water in summer if the recommended dehumidifier system (illustrated on Page 57) is not installed.


SUPPLY DUCT FURRED INTO CIELING
KITCHEN AND PANTRY FAN COIL UNIT
TWO DIRECTIONAL SUPPLY AIR GRILLE
DINING ROOM FAN COIL UNIT
ACCESS DOORS ON SIDE
BRASS RETURN GRILLE SIMILAR TO EXISTING
CHILLED WATER PIPES & CONDENSATE DRAIN.

VERTICAL FAN COIL UNITS

FIGURE 7

SYSTEM SCHEMATIC	FAN COIL UNITS INSTALLED IN STORAGE CUPBOARD	
PROJECT	24 SUSSEX DRIVE	**PAGE** 33

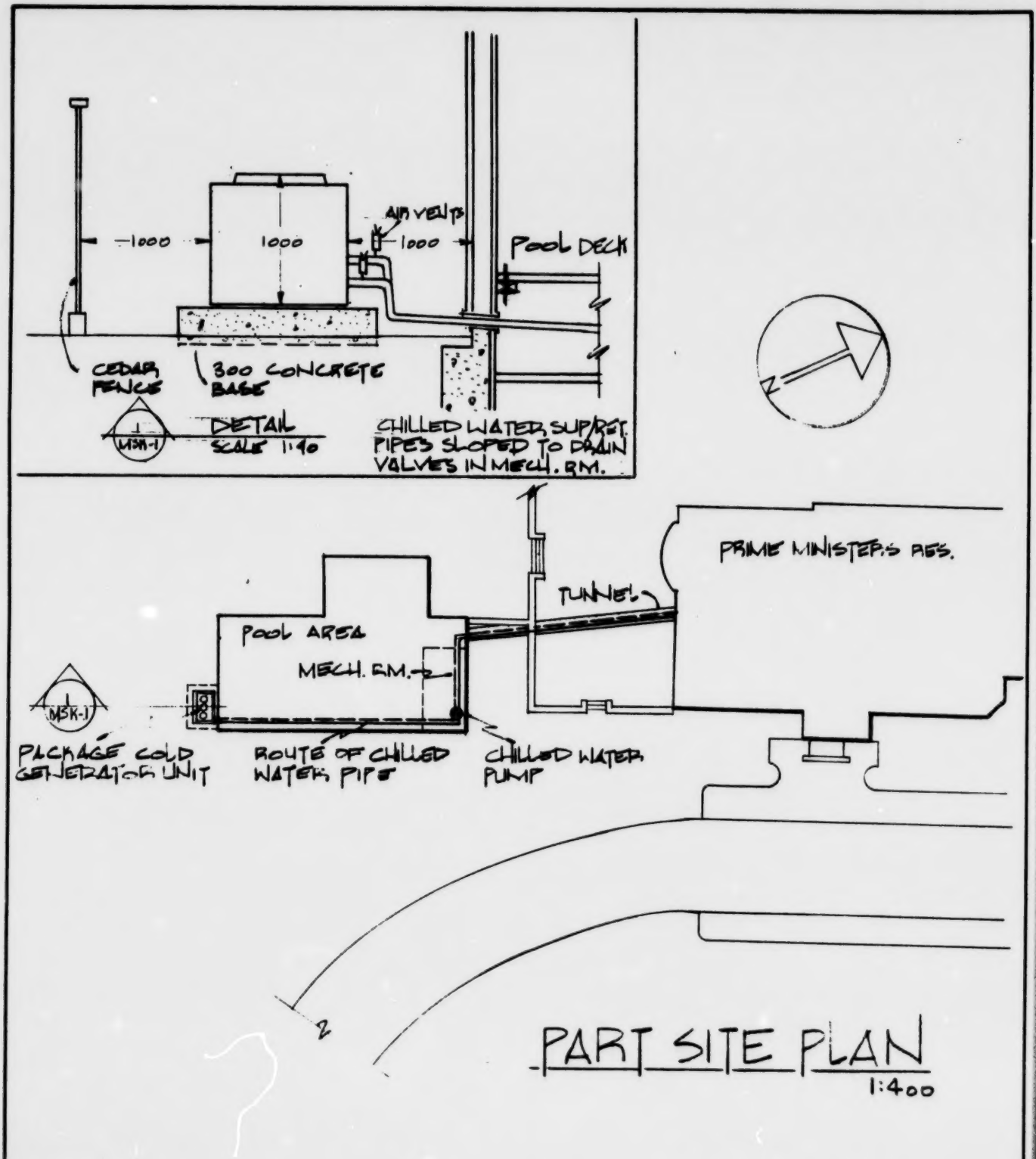


FIGURE 10

SYSTEM SCHEMATIC PROPOSED CHILLED WATER SYSTEM FOR AIR CONDITIONING	
PROJECT 24 SUSSEX DRIVE	**PAGE** 35

7. **AIR CONDITIONING** cont'd

2. **Concept for New System** - cont'd

Estimated Budget Costs:

Complete Air Conditioning System:	$90,000
OR	
Partial Air Conditioning System:	$75,000
* Relocate Kitchen Condensing Unit to the Basement:	$ 500

* This work was recently completed - September 1984

8. SPRINKLER SYSTEM:

The Building Code does not require a sprinkler system in the residence. Because of its 'heritage' value, however, a sprinkler system is considered desirable.

The sprinkler system would be designed and installed to meet the requirements of the Regional Fire Commissioner and, generally, in accordance with the National Fire Code NFPA-13.

The system proposed has two zones; a wet pipe system to serve the basement, ground floor and first floor and, because of the possibility of freezing, a dry pipe system for the second floor and attic.

Existing water service to the residence is 2", reduced from 4" outside. The 4" line will be extended into the building and sprinkler valve assemblies installed in the old oil tank room.

Vertical pipe risers can be concealed in the corner of closets and voids in the walls. Concealing horizontal piping in ceilings presents many difficulties because the ceilings are attached to the underside of the joists which are laid in both directions throughout.

Concealed type sprinkler heads would be used throughout living areas and copper piping would be used to keep pipe sizes to a minimum.

Considerable cutting and patching of finished surfaces will be necessary throughout the residence. Restoration of the decorative ceiling in the dining room would require a skilled specialist. In short, the installation is a major project which would be better undertaken with a complete renovation of the building.

8. **SPRINKLER SYSTEM** - cont'd

A preliminary design made for estimating purposes indicates a total of 125 heads on the wet system and 75 heads on the dry system.

Estimated Budget Cost: $95,000

9. ELECTRICAL DISTRIBUTION:

1. Main Distribution System:

1. Existing:

In 1975 the main power distribution system for the compound was revamped with the construction of the pool building and an indoor Ottawa Hydro transformer vault. The vault contains a 75 KVA transformer which feeds a 400A, 120/240V, single phase service from the pool building to the main house. It also contains a 37½ KVA unit to feed three 120/240V, single phase panels for the pool building and connecting tunnel, and a bank of three 50 KVA units supplying 600V, 3-phase power for the pool and mechanical equipment.

In the main house the 400A service terminates in a circuit breaker distribution panel with distribution breakers to feed various branch breaker panels in the house as well as the chauffeur's residence and other exterior loads on the grounds.

The distribution equipment and wiring in the pool building, and the house feeder up to and including the house distribution panel, are of current vintage and require no alterations.

The distribution in the house consists of the following branch circuit panels:

Panel A: Old breaker panel located in the basement electrical room, serving the basement and ground floor.

9. **ELECTRICAL DISTRIBUTION** - cont'd

1. Main Distribution System - cont'd

1. Existing - cont'd

Panel B: Current vintage breaker panel located in the boiler room, serving the boiler room and some of the sun lounge and rear entrance heating.

Panel C: Current vintage breaker panel located in the staff dining area on the ground floor, serving the main kitchen equipment and ground floor staff area.

Panel D: Current vintage breaker panel located in the dishwashing area, serving equipment in that room only.

Panel E: Old breaker panel located in the back corridor on the first floor, serving the first and second floors.

Panel F: Old plug-fuse panel located in the Sewing Room on the second floor, serving four receptacles in that room.

2. Recommendations:

Panels 'C' and 'D' in the kitchen and Panel 'B' in the boiler room are probably six to eight years old and are in good condition.

Panels 'A' and 'E' on the basement and first floors are 34 years old and should be replaced. They service most of the lighting and receptacle circuits in the residence and, while they are not overloaded from the demand point of view, there are no spare circuits available. It is recommended that they be replaced with 42 circuit panelboards (at present each has only 30 circuits).

9. ELECTRICAL DISTRIBUTION - cont'd

1. Main Distribution System - cont'd

2. Recommendations - cont'd

The small plug-fuse panel (F) should be eliminated entirely and its circuits rerouted to the new panel 'E' as part of the branch circuit replacement to be discussed later in this report.

Estimated Budget Cost:

Panel Replacement Including the Reconnection of Existing Circuits: $1500

2. Branch Circuit Wiring:

1. Existing:

With very few exceptions all of the branch circuit wiring is type RH-BX and is about 34 years old. The BX has a grounding tape but only a few of the receptacles are grounded.

RH insulation on wiring of this vintage is often brittle and poses safety problems. The wiring in this house has not yet reached this stage and could be considered safe for perhaps another five years.

Feeders to all of the panels are type RW-90 and were replaced when the pool was added; no changes to them are necessary.

All existing wiring, both old and recently replaced, is copper.

9. ELECTRICAL DISTRIBUTION - cont'd

2. Branch Circuit Wiring - cont'd

1. Existing - cont'd

Wiring has been added over the years to accommodate various needs. Some has been installed 'exposed' and in a manner unsuitable for a residence of this stature. Notable examples are:

- Exposed wiremold in around the fireplace in the first floor bedroom.
- Exposed aluminum sheath and BX cable for heating and receptacles in the ground floor sunroom.
- Exposed NMD-7 from the sunroom heater outdoors to the boiler room fresh air intake.
- BX cable run through ductwork to a loose receptacle behind the fresh air grille in the Dining Room.
- Stove cord set taped to underground wiring laying in the window well at the front door.

2. Recommendations:

Although the branch wiring is essentially safe for the next five years (except for the odd breach of common safety requirements), it is undoubtedly approaching the end of its useful life. Any major renovation program should include the complete replacement of all branch circuit wiring.

The existing BX has been installed through the stud walls and is anchored to the studs at frequent intervals. It is not possible, therefore, simply to pull out the old while fishing in the new. The most likely method of rewiring will be to first remove as much of the old as possible but, for the most part, to leave it abandoned in the walls.

9. ELECTRICAL DISTRIBUTION - cont'd

2. Branch Circuit Wiring - cont'd

2. Recommendations - cont'd

If, for any reason, all or any part of the house should be totally gutted then the old wiring should be entirely removed.

The new wiring would take the form of NMD-7 non-metallic, sheathed cable. To minimize damage to existing drywall it is suggested that the baseboard mouldings be removed and the new wiring installed behind it. This would serve well for the receptacles and light switches, however new runs to ceiling light fitures would involve extensive cutting and patching. Some of this could be minimized by feeding the second floor from the attic space.

It will be necessary to remove and reinstall all light fixtures to accommodate the rewiring.

Estimated Budget Cost: $42,000

Branch Circuit Replacement Including Light Fixture Reinstatement but Excluding Baseboard Replacement and new Wiring Devices.

3. Wiring Devices:

1. Existing:

With the exception of some recent work in the kitchen area and in the Family Room on the first floor, all of the receptacles in the house are the two-prong, ungrounded type.

9. ELECTRICAL DISTRIBUTION - cont'd

3. Wiring Devices - cont'd

1. Existing - cont'd

These must be changed to grounded type to conform to Code requirements. Lighting switches are also original equipment and are the exposed blade porcelain type. These, too, must be replaced.

2. Recommendations:

It is recommended that all existing wiring devices be replaced as soon as possible. This work would most likely be done in conjunction with the total rewiring of the house. If the rewiring is postponed to a later date, however, the replacement of the devices could, and should, be carried out first.

Three-way switches should be installed in all rooms having two entry doors.

Grounding of the receptacles can be achieved by installing a bare jumper from the ground terminal of the new receptacle to the outlet box since the old BX does have an integral ground tape. Because of the long-term Heritage nature of this residence it is recommended that high quality, specification grade devices be used and that all coverplates be replaced.

Estimated Budget Cost: $4,500
Replacement of Wiring Devices

10. FIRE DETECTION AND ALARM SYSTEM

1. Description of Existing System:

A fire detection and alarm system was installed about thirty years ago by ADT Security Systems Ltd. It consists of a continuous "AERO" closed-loop pneumatic tube (1 circuit per floor) running around the perimeter of every room, with spot detectors in closets and storage rooms. The system operates on the principal that an increase in temperature at any location along the loop will cause an increase in air pressure in the loop. This is sensed by a diaphragm pneumatic/electric switch which triggers the alarm bells, one per floor. Manual pull stations are located at the stairwell on each level. The system is functional, is checked monthly by ADT Security Systems Ltd., and is connected to their central monitor office. A drop-type annunciator panel is located in the staff corridor on the ground floor. Although operational, this system does not meet current D.F.C. standards, is not ULC listed, and, because of the exposed pneumatic tubing, is aesthetically unacceptable.

Each bedroom and corridor in the house has recently been equipped with battery-operated, residential type smoke alarms.

No connection exists from the fire alarm system to the kitchen CO_2 extinguishing system. Contactors are required to shut down the cooking equipment under the CO_2 system, and the exhaust fan, if the system is triggered.

2. Recommendations:

The existing detection/alarm system must be removed and replaced with a new system which complies with F.C.C. Standard 410M.

10. **FIRE DETECTION AND ALARM SYSTEM** - cont'd

2. Recommendations - cont'd

The new system would consist of new manual stations at the exits from each level, two alarm bells per floor, heat detectors in all storage rooms and closets, ionization type smoke detectors in each corridor and at the top of stairwells, a heat detector at the top of the elevator shaft, and a combination heat detector/smoke alarm in each bedroom. A new control panel with battery backup would be installed on the ground floor, with a remote zone annunciator located in the RCMP guardhouse. Connection to a central monitoring agency would be retained.

Because of the extensive amount of wiring involved, this work will incur major damage to interior finishes.

Estimated Budget Costs: $15,000

New Fire Alarm System

11. GROUND FAULT PROTECTION

1. Existing:

Ground fault protection devices are required for all electrical equipment within ten feet of the pool surface and for all receptacles in washrooms.

At present the pool underwater lighting circuit is protected. Protection is required for perimeter fluorescents in the pool valance system, for receptacles in the sun lounge, and for sun lounge baseboard heaters.

Some bathrooms have receptacles with insulation transformers. Although these are acceptable by Code they cannot withstand larger loads, such as hair dryers or curling irons.

2. Recommendations:

Install ground fault sensing circuit breakers for pool area lighting, heating and receptacles, and for all washroom receptacles.

Estimated Budget Cost: $1200

12. TELEPHONE AND CATV SYSTEMS:

1. Existing:

The telephone distribution system originally installed consisted of terminal cabinets in the basement and on the second floor and EMT conduit to approximately twelve permanent outlets.

Since that time outlets have been added or relocated to suit the occupants' needs, and any additional cabling was installed 'exposed', following baseboards, door frames and stair risers. Most of this exposed cable is found in the rear staircase and in the rear bedroom wing of the first and second floors.

The telephone system is a standard, leased Bell Canada system which utilizes a multiple conductor cable to each outlet.

Discussions with the Telecommunication Officer of the Privy Council revealed that recommendations to install a new telephone system are forthcoming. The new system will likely be a proprietory, electronic, private branch exchange with expanded facilities for more incoming and outgoing lines, and an intercom capability. Wiring for the new system will take the form of a small diameter, four conductor, jacketed cable which can be concealed easily.

The cable television (CATV) system was added to the house about ten years ago and the cabling is entirely exposed. The main entry cable to the upper floors has been run up the outside of the house on the southeast corner and enters through the window sill of a second floor bedroom.

12. **TELEPHONE AND CATV SYSTEMS** - cont'd

1. Existing - cont'd

Cabling is exposed along baseboards and door frames throughout the first and second floors. Although the system is functional, any aesthetic renovations should include concealment of this cabling, and underground entrance to the building.

2. Recommendations

The entire telephone and CATV cabling should be renovated. Four-conductor, JKT and type RG48-U co-axial cable should be installed, either concealed behind baseboards or fished in from accessible spaces such as the attic. New flush-mounted telephone and TV outlets should be installed in each bedroom.

It is recommended that a dedicated telephone outlet be furnished for each room in the house except for storage areas and other non-occupied spaces.

CATV outlets beyond the bedrooms should be discussed with the occupants.

Estimated Budget Cost: $4,500

New Telephone and CATV Distribution to approximately 23 locations

13. EMERGENCY POWER:

1. Existing:

The only standby power in the house is an emergency battery lighting unit in the pool mechanical room serving the pool staircase, the equipment room and the connecting tunnel.

2. Recommendations:

Because the Regional Fire Commissioner has requested that emergency power be added it is recommended that a central A.C. battery-powered invertor/rectifier unit be installed in the basement complete with two small 120V load centres (one in the basement and one on the first floor), to provide power to the corridor and stairwell lighting circuits. This unit would have a capacity of approximately 4500 VA.

Estimated Budget Cost: $14,000

14. LIGHTNING PROTECTION

1. Existing:

No lightning protection exists. Several proposals have been submitted to Public Works Canada in the past few years along with completed designs and budgets. Any new system would involve approximately 45 air terminals on the roof, interconnecting grounding cables, connections to metal roofing, and exterior vertical drops to buried ground rods or mats.

2. Recommendations:

We concur with the Regional Fire Commissioner that lightning protection should be installed due to the historical value of the residence and its high risk location in terms of a lightning strike. Because virtually all of the work is exterior, the system could be installed at any time with very little inconvenience to the occupants.

Estimated Budget Cost: $7,500

15. SWIMMING POOL:

1. Description of Building:

The pool building was constructed in 1975, of wood frame construction, with tongue and groove cedar cladding, 4" fibreglass batt insulation between 2"x 6" studs, 6 mil plastic vapour barrier, and tongue and groove cedar on the interior. The roof consists of tongue and groove decking with rigid insulation (thickness not ascertained) and built-up roofing. Heating cable for ice melting is lying loosely near the parapets and scuppers.

Problems have developed with the skylights; the small horizontal one on the east end was replaced recently and the surrounding roof rebuilt. Seals on most glazing units, which are inclined at 45° in the main skylight, have failed, thereby reducing the insulation value. This failure is attributed to the size of the skylights and to the expansion and contraction to which they are subjected.

It was reported that the condensation on the large sliding double section patio door in the sun lounge freezes in winter. Attempts to adjust the weatherstripping will not be successful. The windows of the sun lounge also become frosted over in cold weather due to exposure to the humidity from the pool area. It was noted that a wooden trim strip, designed to keep the heavy curtains away from the electric baseboard heaters, has become charred, indicating that a fire hazard exists.

High humidity in the pool building is definitely detrimental to the structure and unless steps are taken soon to improve the situation long-term deterioration can be anticipated.

15. **SWIMMING POOL** - cont'd

2. Recommendations:

The roof heating cable, for keeping the parapets clear of ice, should be fastened to clips soldered to the flashing strips.

Replace skylights with triple glazed units half the length of the existing. Polycarbonate, double panelled units could be used but the frame would probably have to be rebuilt unless a supplier can be found who manufactures custom sizes.

A radical approach to improving the skylight arrangement would be to remove the existing structure entirely and frame the large roof opening to accept several standard horizontal skylights. The appearance of the building would be altered, consequently this approach would require further study.

Replace the large sliding patio door with a superior quality, three-section unit with one active leaf sliding on a double weatherstripped track.

Install a glazed partition with weatherstripped french doors between the pool area and the sun lounge to reduce the humidity in the sun lounge. The partition would be located at the change of floor level, which would incur the relocation of the steps further north. An aluminum, prefinished channel would replace the charred wood above the baseboard heaters. If the sun lounge is used extensively in winter, consideration should be given to the installation of supplementary radiant heating in the ceiling to improve comfort.

15. SWIMMING POOL - cont'd

2. Recommendations - cont'd

There are no visible signs that the roofing system requires replacing but when this does occur in the future, it is recommended that an inverted system be used where the membrane is placed between the cedar deck and the insulation.

The door between the basement recreation room and the tunnel connected to the pool building is kept locked. It is recommended that a floating pool alarm be installed which would give an audible warming in the house if children enter the pool unsupervised.

The method of reducing the humidity level is described under the Mechanical System.

Estimated Budget Costs:

Replace Skylights:	$12,000
Replace Sliding Patio Door:	$ 3,200
Install New Glazed Partition and Doors and Relocate Steps:	$ 7,000

3. Description of Mechanical System:

The pool water filtration system is a pressure, permanent media, sand type with high flow rate. It is a self-contained unit; the pump, hair strainer, backwash valve etc. are mounted on top of the filter cylinder, as is typical for this size of pool. Piping from the skimmers and to the wall inlets is ABS plastic. Valves are plastic ball type. A resistance type electric water heater is installed on a bypass loop off the main water supply line. The pool building is heated electrically. Continuous baseboard convectors heat the sun lounge and smaller baseboard heaters are installed in the changing area.

15. SWIMMING POOL - cont'd

3. Description of Mechanical System - cont'd

The pool enclosure is heated by a duct coil in the ventilation unit located in the basement. Warm air is supplied through floor grilles in the pool deck and returned at one end.

Humidity is controlled by a room humidistat mounted in the return air duct, controlling in two stages the two exhaust fans in the gable ends of the skylight. On the first stage the fresh air damper opens to 50% open with one exhaust fan running. If the humidity level rises further, the fresh air damper opens fully and the second exhaust fan starts. The humidity controller is not a high quality instrument, however, and will not control accurately.

As noted elsewhere, the moist air condenses on the underside of the skylights and the exhaust fans do little to reduce this condensation.

The pool ventilation system does not perform well and is wasteful. The constant evaporation of pool water (due to vapour pressure difference) produces high humidity in the pool enclosure. This process causes a steady heat loss of the pool water, requiring steady pool water heating.

The high latent heat loss from the water passes to the air which must be exhausted to maintain conditions which are not destructive to the building. The air which is exhausted must, in turn, be replaced by drier fresh air which, in winter, is heated to room temperature.

15. SWIMMING POOL - cont'd

4. Recommendations

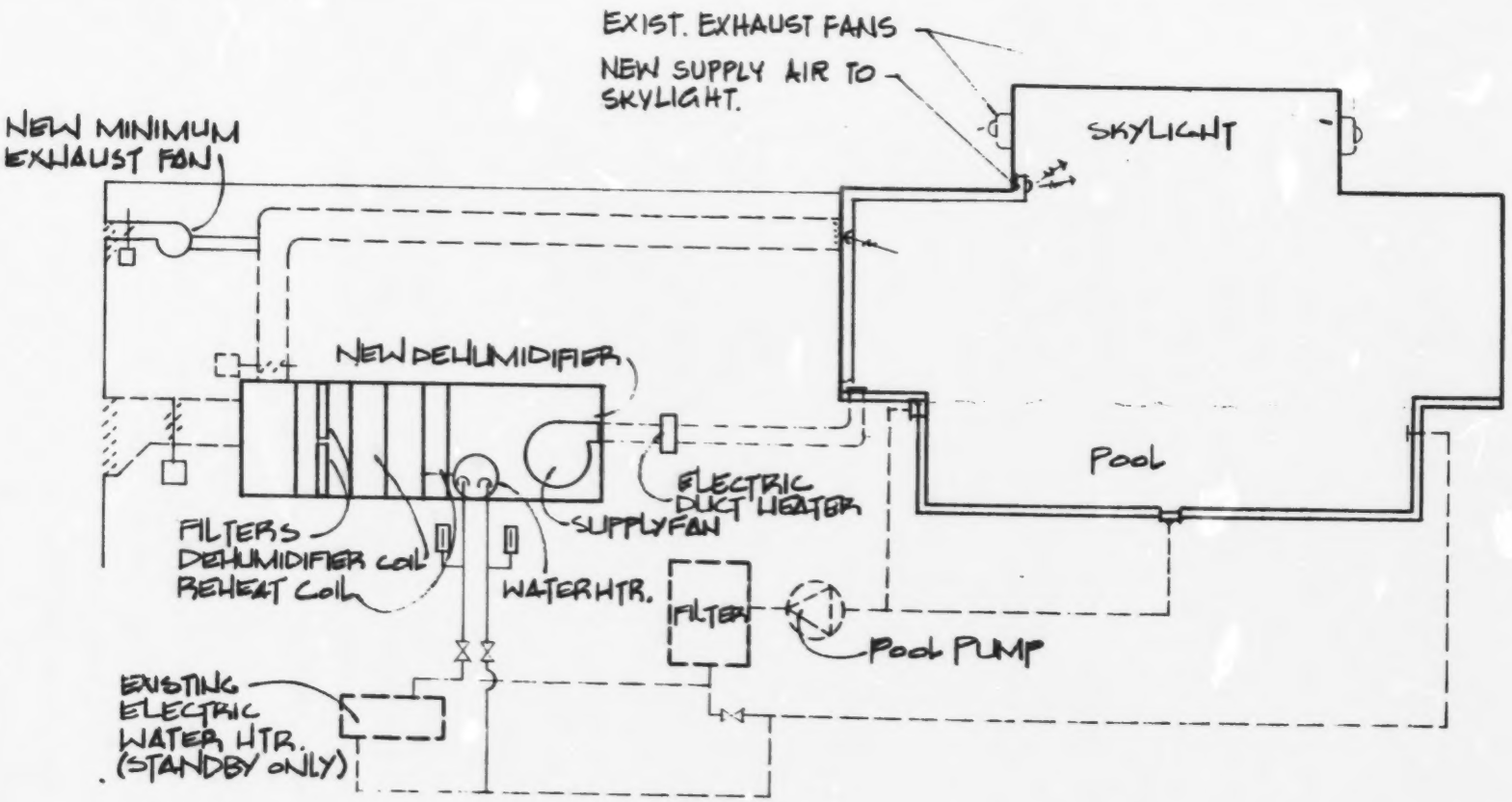
Recovery of some of the heat exhausted, by using either a heat wheel, a coil loop, a thermo-syphon heat exchanger, or a fixed plate air-to-air heat exchanger, is not recommended because of the difficulty of providing a constant building negative pressure, and the necessity of frost control required with high humidity exhaust.

A refrigeration system which dehumidifies the air and utilizes the rejected heat to heat the pool water and pool enclosure provides an effective and energy-conserving method of humidity control and is the system recommended. The system arrangement is shown on Page 57.

After being drawn into the dehumidifier unit, the warm moist air from the pool area is cooled below its dew-point, which condenses the moisture in the air. The sensible and latent heat removed by the cooling coil is absorbed by the refrigeration system, and rejected by heating both the pool water and the air returned to the pool area.

The electrical energy used to operate the dehumidifier is utilized in the pool heating requirements and no other energy is required except for normal building transmission and infiltration losses.

Packaged dehumidifier units which incorporate a water heater and which are designed specifically for indoor swimming pools are available from Dectron Incorporated, a Canadian manufacturer. The economic analysis which follows indicates a payback of 6½ years for this system.



SWIMMING Pool DEHUMIDIFICATION SYSTEM

15. SWIMMING POOL:

4. Recommendations - cont'd

A small exhaust fan maintains a negative pressure within the pool enclosure at all times. In summer, when the pool water heating requirement is satisfied, the refrigeration unit is shut off to prevent overheating. At this time the fresh air damper opens fully and the existing exhaust fans start and continue to run until the pool water thermostat calls for heat and starts the dehumidifier unit again.

The existing exhaust fans are noisy but, with the above concept, they will run only in the summer when less time will be spent inside.

The existing humidistat will be replaced by an electtronic, industrial quality instrument with remote setpoint adjustment.

To reduce the condensation under the skylight a branch duct with a small booster fan and adjustable punkah-type outlets directing dry supply air at the glass can minimize this problem. The branch duct would be installed in the corner and across the ceiling in a cedar enclosure to blend with the existing finishes.

Estimated Budget Costs:

New Dehumidifier System:	$24,000
Skylight Supply System:	$ 2,800

15. SWIMMING POOL - cont'd

5. Economic Analysis of Replacing Existing Make-up Air Unit and Exhaust System with New Dehumidifier Unit

General Data:

Pool Surface Area: 74.32 m^2 (800 sq.ft.)

Pool Water Temp. (Average): 27.8°C (82°F)

Pool Air Temp. and Humidity (Average): 28.9°C (84°F) 60% R.H.

Comparison of Operating Costs:

Pool Evaporation Rate = 800 sq.ft. x 0.0206 lb/sq.ft.*

= 16.48 lb/hr.

* Carrier empirical formula

Select Dectron Model DS-16 with a capacity of 19 lb/hr. at operating conditions.

1. Energy Requirement Using Outside Air:

An average of 1435 BTU is required to heat outside air to replace humid air exhausted plus 1000 BTU lost from the pool water due to evaporation.

Therefore:

Heating Season Energy Requirement per pound of Evaporation: $\frac{1435 + 1000}{3412}$

= 0.71KW/lb.

Total Heating Season Requirement: = 0.71 x 16.40 lb/hr x 7600 hours

= 88,926 KWH

Summer Season (Water Htg.Only)

Heat to Evaporate 1 lb. Water = $\frac{1000 \text{ BTU}}{34.12 \text{ BTU/KW}}$

= 0.3 KW/lb.

Energy Requirement = 0.3KW/lb x 16.48 lb/hr x 1136 hrs per season

= 56.6 KWH

Total Energy Requirement with Existing Pool System:

= 88,926 + 5616 = 94,542 KWH

15. SWIMMING POOL - cont'd

5. Economic Analysis of Replacing Existing Make-up Air Unit and Exhaust System with New Dehumidifier Unit (cont'd)

2. Energy Requirement With Existing Pool System:

Heating Season: Water Heating + Humidity Control:

= 16.48 lb/hr x 7600 hrs. x 0.243 KW/lb. *

= 30,435 KWH

* Dehumidification capacity of Dectron DS-16.

The 30,435 KWH consumption is attributed to the space heating and can be deducted, therefore, from the heating requirement of the pool enclosure.

Summer Season: Using Dectron Model DS-16

Nom.Evap.Rate: $\frac{16.48 \text{ lb/hr} \times 1000 \text{ BTU/lb}}{3412 \text{ BTU/KW}}$ = 4.83KW

Total Compressor Power Consumption (DS-16) = 3.80KW

Air Cooling: $\frac{2000 \text{ CFM} \times 1.08 \times 3°\text{F}}{3412 \text{ BTU/KW}}$ = 1.90KW

TOTAL POOL WATER HEATING CAPACITY: 10.53KW

Summer Hours of Operation = $\frac{5616 \text{ KWH}}{10.53 \text{ KW}}$ = 533 hours

Therefore:

Summer Energy Consumption: 533 hrs.x 3.8KW = 2025 KWH

Annual Energy Saving Using Dehumidifier Unit:

= 94,542 KWH - 2025 KWH = 92,517 KWH

Annual Cost Saving: 92,517 KWH x $0.04/KWH = $ 3,700

Estimated Installation Cost = $24,000

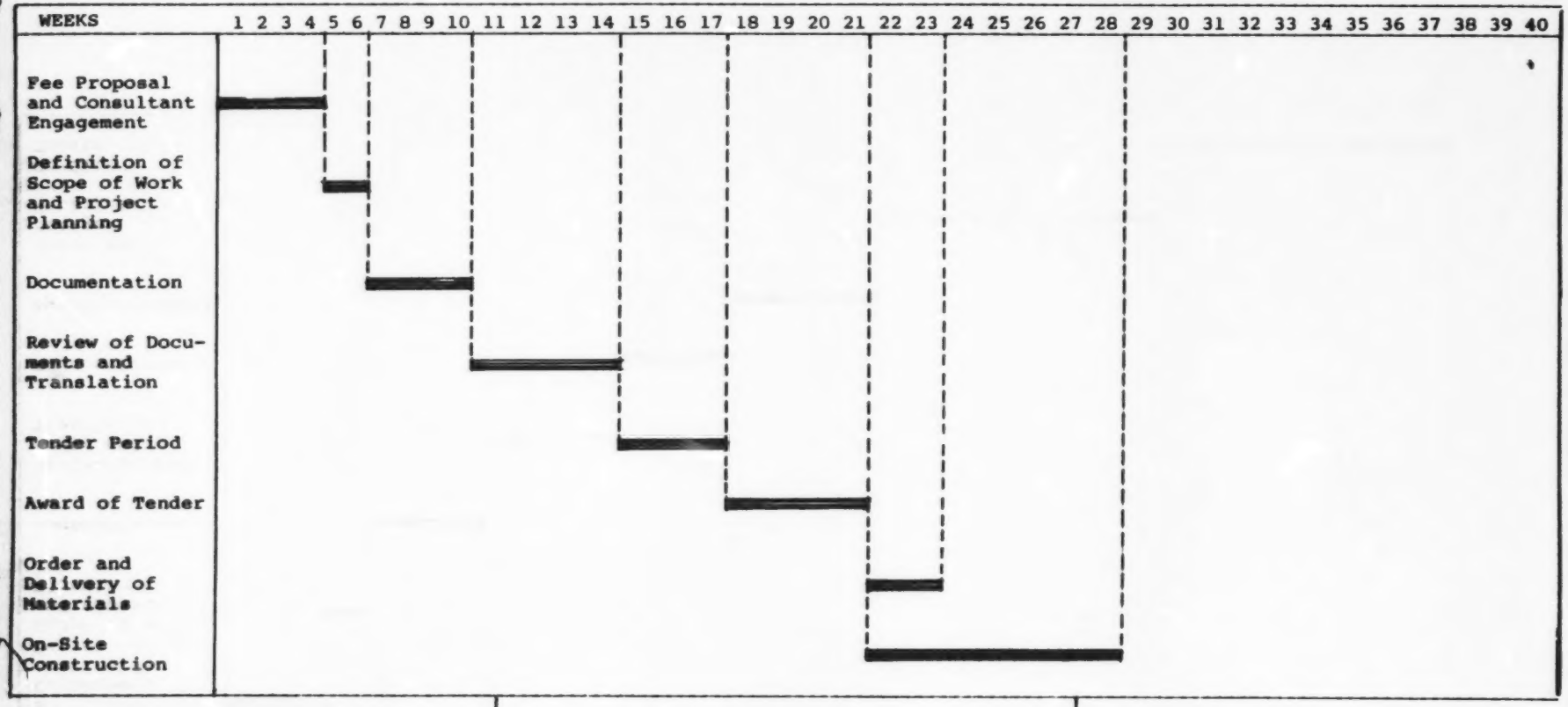
Therefore, Payback = $\frac{24,000}{3700}$ = 6½ years

APPENDIX "A" - SUMMARY OF RECOMMENDED WORK

	Estimated Budg.Cost	On-Site Construction Time
1. Building and Structural Elements:		
Build new dwarf walls in attic	$ 8,000	2 weeks
Repoint/rebuild top sections of chimneys	$20,000	4 weeks
Replace all windows	$90,000	6 weeks
Additional attic insulation	$ 4,500	1 week
Insulate basement crawl spaces	$ 6,000	2 weeks
Repair roof of Living Room Bay window and build new deck off Master Bedroom	$ 4,000	2 weeks
2. Mechanical:		
Replace all bathroom fixtures and galvanized piping	$35,000	12 weeks
Clean all convectors and modify to increase efficiency	$ 5,300	2 weeks
Increase heating capacity in kitchen, pantry, family room, staff dining, storage and main entrance	$ 8,700	8 weeks
New bathroom exhaust and replacement air system	$ 9,500	8 weeks
New kitchen exhaust and replacement air system	$17,600	8 weeks
New oven vents to outside	$ 1,200	1 week
New laundry room exhaust	$ 2,200	1 week
Modify sewing room exhaust system	$ 600	2 weeks
Complete air conditioning system	$90,000	12 weeks
OR		
Partial air conditioning system	$75,000	10 weeks
Relocate freezer condensing unit	$ 500	1 week
New sprinkler system	$95,000	20 weeks
3. Electrical:		
Replace old electrical panels	$ 1,500	1 week
Replace electrical branch circuits	$42,000	8 weeks
Replace all existing wiring devices	$ 4,500	1 week
Replace fire detection/alarm system	$15,000	4 weeks
Install ground fault devices	$ 1,200	1 week
Install new telephone and CATV distribution system	$ 4,500	4 weeks
Install new battery emergency power	$14,000	12 weeks
Install lightning protection	$ 7,500	2 weeks
4. Pool Building:		
Replace pool ventilation unit with dehumidifier system	$24,000	12 weeks
Install skylight supply air system	$ 2,800	4 weeks
Replace pool skylights	$12,000	2 weeks
Replace sun lounge sliding door	$ 3,200	1 week
Install new glazed partition between pool area and sun lounge	$ 7,000	2 weeks

PROJECT SCHEDULE

PACKAGE "A" - PRIORITY ITEMS


WEEKS
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
Fee Proposal and Consultant Engagement
Definition of Scope of Work and Project Planning
Documentation
Review of Documents and Translation
Tender Period
Award of Tender
Order and Delivery of Materials
On-Site Construction

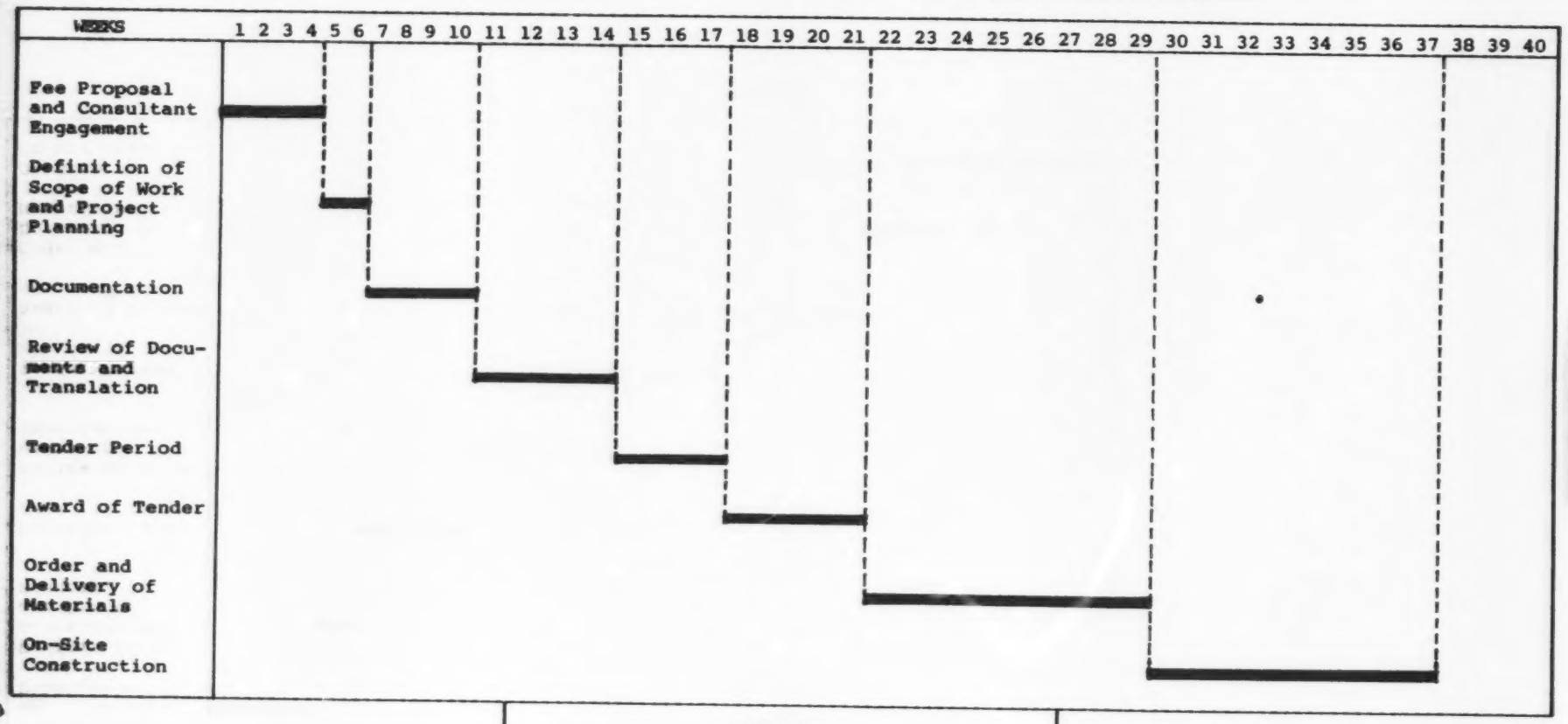
SUMMARY:

Preparation and Off-Site Work:	21 weeks
On-Site Construction:	7 weeks
TOTAL:	28 weeks

APPENDIX "B" - 1

PROJECT SCHEDULE

PACKAGE "B" - UPGRADING BUILDING ENVELOPE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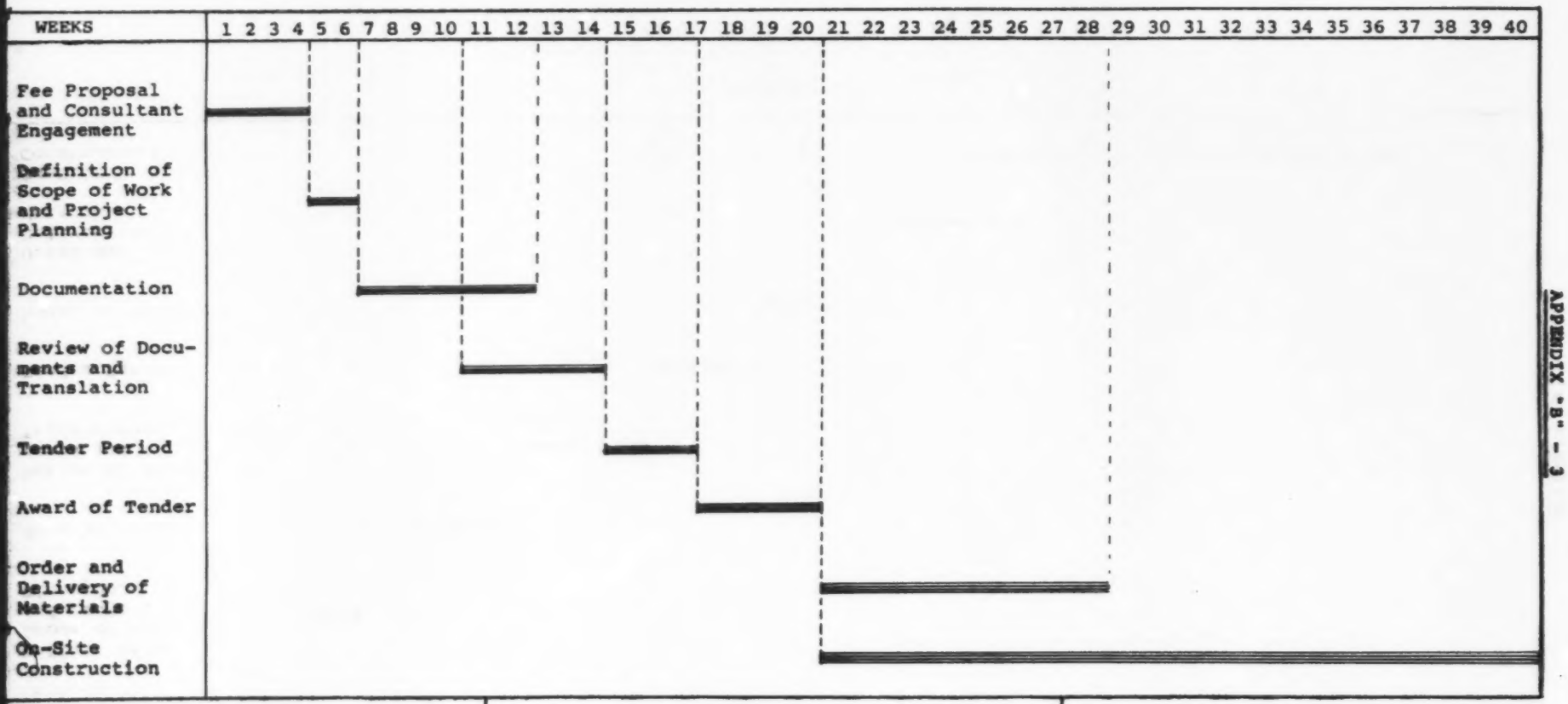
APPENDIX "B" - 2

SUMMARY:

Preparation and Off-Site Work:	29 weeks
On-Site Construction:	8 weeks
TOTAL:	37 weeks

PROJECT SCHEDULE

PACKAGE "D" - NEW SYSTEMS


WEEKS
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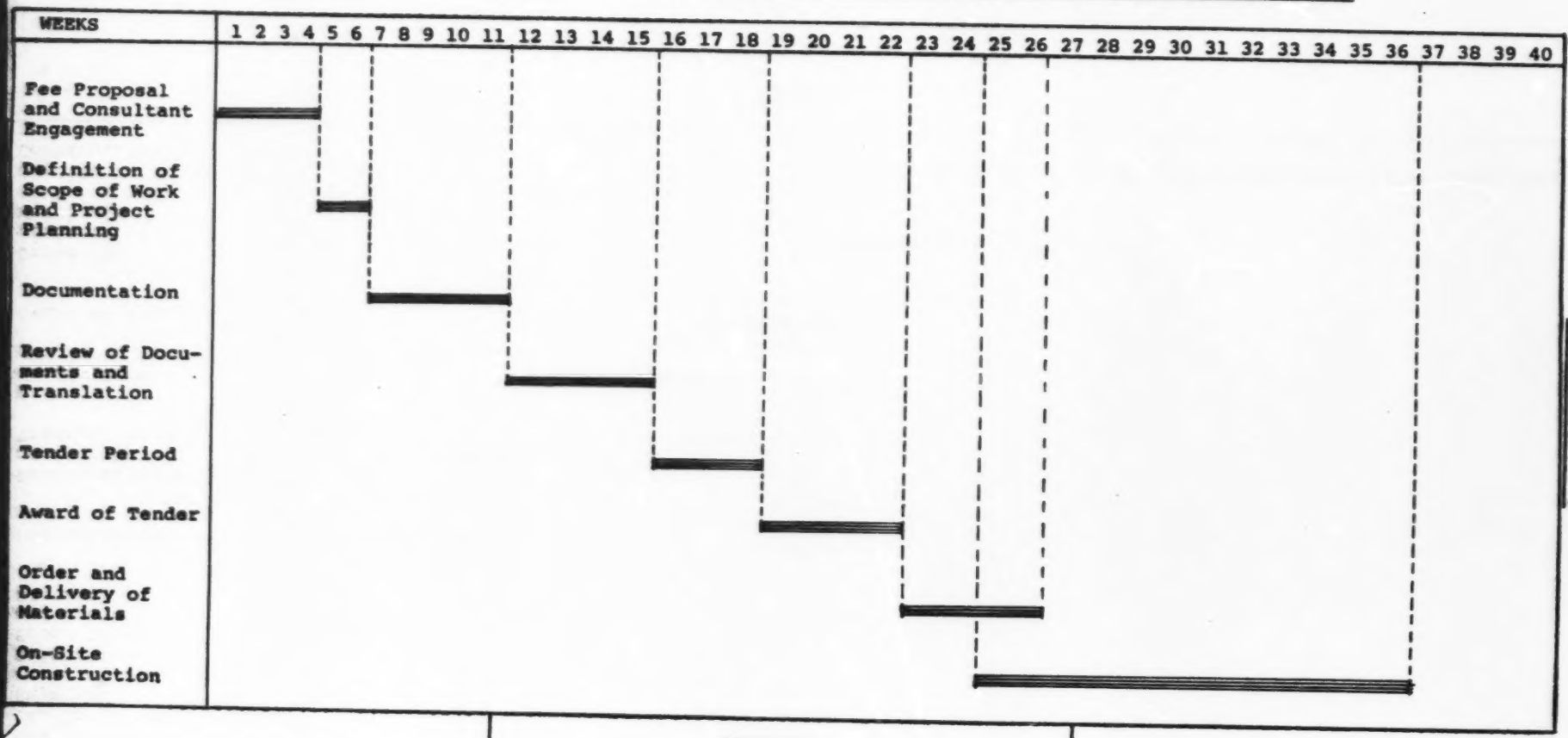
APPENDIX "B" - 3

SUMMARY:

Preparation and Off-Site Work:	20 weeks
On-Site Construction:	20 weeks
TOTAL:	40 weeks

PROJECT SCHEDULE

PACKAGE "C" - UPGRADING MECHANICAL AND ELECTRICAL SYSTEMS


WEEKS
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Fee Proposal and Consultant Engagement
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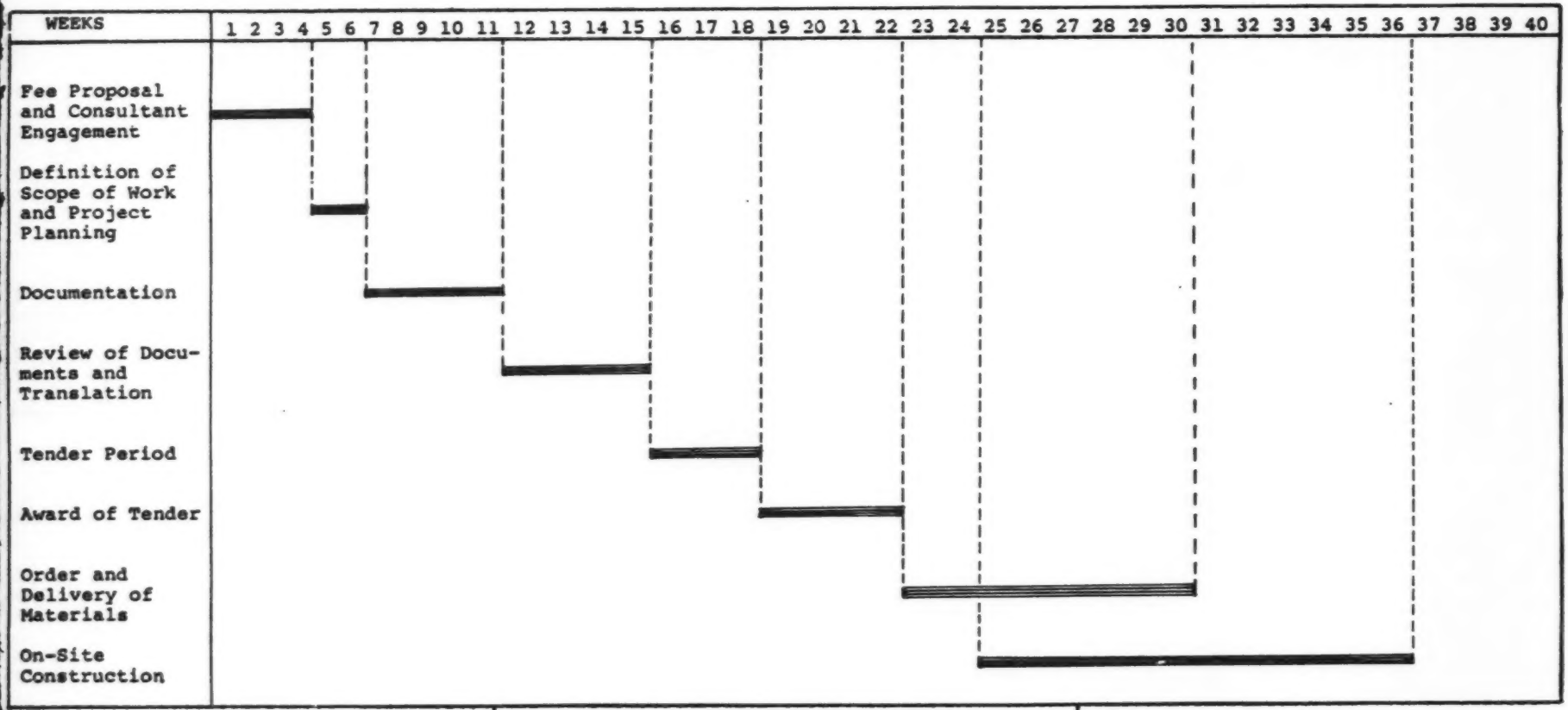
On-Site Construction

SUMMARY:

Preparation and Off-Site Work:	24 weeks
On-Site Construction:	12 weeks
TOTAL:	36 weeks

PROJECT SCHEDULE

PACKAGE "E" - POOL BUILDING


WEEKS
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Fee Proposal and Consultant Engagement
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Tender Period
Award of Tender
Order and Delivery of Materials
On-Site Construction

SUMMARY:

Preparation and Off-Site Work:	24 weeks
On-Site Construction:	12 weeks
TOTAL:	36 weeks